USARDSG (UK)

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Coordination of Mesoscale Meteorological Research
between ASL and European Groups

Principal Investigator : Professor R.P.Pearce

Contractor : University of Reading, U.K.

Contract Number : DAJA 45-90-C-0009

FOURTH INTERIM REPORT
1st February 1991 - 31st July 1991

The main activity undertaken during this period was the finalisation of the arrangements for the Mesoscale Model Comparison Project. The four components of the project are (i) publication by ASL of a pre-workshop volume containing descriptions of all of the models used in the project, (ii) publication by ASL of a pre-workshop volume containing model simulations of the Project WIND data set, (iii) the workshop itself and (iv) publication by the American Meteorological Society of a scientific monograph giving a state-of-the-art assessment of mesoscale modelling based on the project results. The project will enable the U.S. Army to optimise its meteorological information by identifying through the project the most accurate and useful existing models for meeting its particular needs and lay a firm basis on which to develop its own future models (and, to some extent, observing systems).

An outline of the Project was sent in February to the groups which had expressed an interest in participating and their comments invited. At the same time a set of WIND data tapes was sent to Dr. Alpert at Tel Aviv University for his assessment of their quality and readability, and the modelling group at ASL under Mr. Meyers and Dr. Henmi carried out some tests of the computer runs proposed for the participants.

A two-day meeting of the Panel was held in Bruges, Belgium on 9-10 May to consider the responses received and reports from Dr. Alpert and ASL on their tests. A finalised list of requirements of the participants was drawn up and the content of the formal letter of invitation to participants agreed. This letter was sent to all eight participants on 18th July. Also as a result of this meeting a request was sent to Mr. Comati for a supplement of $36,000 to the grant to cover page charges for the AMS, travel and subsistence for speakers invited to the workshop, and travel and subsistence for Professor Pearce and Dr. Pielke to visit ASL in January/February 1992 to assist in the preparation of the pre-workshop results volume.

Copies of the Trip Report of the Bruges meeting and the letter of invitation sent to Project participants are attached. The latter contains full details of the Project.

Professor R.P.Pearce
29 July 1991

Enc. Report of 19th meeting of Mesomet Advisory Panel
Letter to participants in Mesomet Model Comparison Project.

Mr. R. Meyers,
Atmospheric Sciences Laboratory,
SLCAB-AR-M,
White Sands Missile Range,
New Mexico 88002,
U.S.A.

18th July, 1991

Dear Ron,

Mesomet Model Comparison Project

Following the recent meeting of the US Army Mesomet Panel to discuss arrangements for the project, at which comments from participants were gratefully received, I am now able to let you have full details. These are broadly similar to those described in my earlier letters, but now include a slight extension (to Jan 15, 1992) of the time allotted for performing the numerical experiments and a reduction in the the amount of data to be submitted to ASL by that date on floppy disks. The data formats are specified in Annexes 2 and 2A to this letter. Also the workshop has been rescheduled to June. The dates have now been fixed as the 3 days Tuesday 16 to Thursday 18 June 1992.

There are four components of the project - the production of two volumes of pre-workshop proceedings (one containing model descriptions and the other a selection of the results submitted on the floppy disks), the workshop itself and a post-workshop scientific monograph on the present status of mesoscale modelling to be published, subject to peer review, by the AMS.

1 Pre-workshop volume containing model descriptions.

Model descriptions should be somewhat enhanced as indicated in Annex 1 and submitted to Mr. Robert C. Brown, Atmospheric Sciences Laboratory, White Sands Missile Range, New Mexico 88002 by 1 September 1991 for editing by Mr. Ronald E.Meyers.

2 Pre-workshop volume containing model outputs.

The requirements for outputs on floppy disks have now been modified following a pilot run carried out at ASL. Full specifications, including formats, are given in Annexes 2 and 2A. The disks must be received at ASL by 15 January 1992. The outputs will be examined at ASL by Mr. Meyers and myself to select for publication in this volume the most interesting and instructive results. This can amount to only about 20% of the total data if this volume is to be kept to a manageable size of about 300 pages. The outputs will be converted at ASL for graphical reproduction, the records selected being the same for each participating group. Some statistical parameters comparing surface observations (for which an adequate data base of 1 minute observations at 21 stations exists) with simulations will also be computed at ASL and published in this volume.

3 The workshop at ASL.

The dates have now been fixed as 16 - 18 June 1992. An outline programme is attached as Annex 3. Following a presentation on the Project WIND data base participants will be asked to highlight their results and present their own conclusions from their model runs. On the third day we will schedule six special topic scientific discussions, each introduced by an invited expert. It is in these that the main scientific aspects of the project will be concentrated and, in particular, such issues as model forecasting capabilities and field data constraints considered. Participants are asked to submit one-page abstracts of their contributions to these symposia to Mr. Bob Brown at ASL by 15 May 1992 for copying and distribution to participants at the workshop.

4 The AMS scientific monograph.

The American Meteorological Society have agreed to publish papers presented at the workshop as a monograph, subject to peer review. It is intended that this monograph should provide a state-of -the-art assessment of mesoscale modelling as far as it can be made on the basis of the model experiments using the Project WIND data set. It is anticipated that contributors to the scientific discussions will already have prepared papers to present at the workshop which they will submit for inclusion in this monograph. Finalised manuscripts will be requested for refereeing by 13 July 1992 which, hopefully, will enable the monograph to be edited and published by the end of 1992.

It is now planned to despatch both phases of WIND data (on two magnetic tapes) and land height at 1 km intervals (on magnetic tapes) to all participants on 15 July. A check has been made that the WIND data files are transferable without difficulty onto an IBM workstation (RISC/6000), so it is hoped that no participant will experience any difficulty in reading these tapes.

I hope that you can see no difficulties in carrying out the plans outlined here and can confirm your intention to proceed with the project. It would be helpful if, even at this early stage, you could indicate in your reply your anticipated contributions to the scientific discussions.

Regarding financial support, if you will let me have instructions concerning the payment of the $5000 mentioned in my first letter, I will arrange for this sum to be forwarded to you on receipt of your results on floppy disks. Nine groups, from the US and Europe, have indicated their wish to participate. I will circulate a list of participants and invited speakers in due course.

I look forward to receiving your response.

Yours sincerely,

Robert P. Pearce
Chairman, US Army Advisory Panel on Mesometeorology.

Encs.

ANNEX 1

Please provide summary tables with equations, references, and model descriptions using the outline below for guidance. Use as much room as needed.

---

a. Equations:

conservation of mass/species

momentum

energy balance- temperature

other

address level of physics- closures on above and treatment of
- pressure treatment- deviations
- deviations
- closures
  - sub-grid/Reynolds closures
  - up and down scale energy transport
  - moment closures
  - length scaling
  - dissipation
  - triple products
  - covariances
  - pressure gradient-velocity
  - eddy diffusivities

---

b. Dimensionality

---

c. Grid

Horizontal Grid Spacing

Vertical Grid Spacing

Model Domain

Coordinate System
- generalized
- orthogonal
- non-orthogonal
- structures
- pressure/height based coordinates
- utm
- lat/long
- other

d> Analysis methodology

e. Model initialization procedure

- adjoint equations
- normal modes
- nudging
- balance equations
- cold start- hot start properties
- 4 D data assimilation
- adiabatic/ non-adiabatic

f. Solution Techniques

g. Boundary Treatment

upper boundary treatment

- radiative
- absorption
- Rayleigh-Newton adjustment
- other

side boundary conditions

- inflow/ outflow
- nudging

Lateral Boundary layer

wave treatment

Surface Boundary Conditions

h. Canopy treatment

- form drag
- profiles
- analytic profiles
- resolution
- matching conditions
- drag
- evapotranspiration

i. Soil treatment
    methodology
    resolution
    moisture
    evapotranspiration
    energy balance
    heat treatment

j. surface boundary layer treatment
    methodology
    over water treatment
    waves
    sea shore treatment
    additional complex terrain features
    interaction with canopy
    drag

k. Special conditions in which the model can also run

    Arctic Conditions

    Tropical Conditions

l. Cumulus Parameterization
    phases

m. Radiation Parameterization

    long wave
    short wave
    multiple interaction

n. Stable Precipitation Algorithm
    phases

o. Algorithm to link to other models

p. Numerical procedure on each of above
   Stability and order of accuracy
   smoothing
   operator splitting
   alternating direction integration
   time-space stencil
   robustness
   oscillations and wiggles
   artificial diffusion/dissipation
   numerical tests
   wave treatment

q. Coding practices

   operating systems
   languages
   - Fortran 77
   - Fortran 90
   - other
   documentation
   parallelization
   vectorization
   modularity
   computers
   visualization
   standards

ANNEX 2A

Suggested Format of Output

The following formats are suggested for the outputs which will be examined at the ASL.

(a) Horizontal Fields

```
WRITE(IFILE,*)"SURFACE VALUES"

WRITE(IFILE,*)DAY,TIME        ! TIME IS EITHER GMT OR LST
WRITE(IFILE,*)((SH(I,J),I=1,IMAX),J=1,JMAX)
WRITE(IFILE,*)((SLH(I,J),I=1,IMAX),J=1,JMAX)
WRITE(IFILE,*)((SM(I,J),I=1,IMAX),J=1,JMAX)
WRITE(IFILE,*)((P(I,J),I=1,IMAX),J=1,JMAX)
WRITE(IFILE,*)((R(I,J),I=1,IMAX),J=1,JMAX)

WRITE(IFILE,*)"10 M LEVEL VALUES"
WRITE(IFILE,*)DAY,TIME
WRITE(IFILE,*)((U(I,J),I=1,IMAX),J=1,JMAX)
WRITE(IFILE,*)((V(I,J),I=1,IMAX),J=1,JMAX)
WRITE(IFILE,*)((W(I,J),I=1,IMAX),J=1,JMAX)
WRITE(IFILE,*)((T(I,J),I=1,IMAX),J=1,JMAX)
WRITE(IFILE,*)((Q(I,J),I=1,IMAX),J=1,JMAX)
WRITE(IFILE,*)((UW(I,J),I=1,IMAX),J=1,JMAX)
WRITE(IFILE,*)((VW(I,J),I=1,IMAX),J=1,JMAX)
WRITE(IFILE,*)((H(I,J),I=1,IMAX),J=1,JMAX)
WRITE(IFILE,*)((LH(I,J),I=1,IMAX),J=1,JMAX)

WRITE(IFILE,*)"500 M LEVEL"
WRITE(IFILE,*)DAY,TIME
WRITE(IFILE,*)((U(I,J),I=1,IMAX),J=1,JMAX)
WRITE(IFILE,*)((V(I,J),I=1,IMAX),J=1,JMAX)
WRITE(IFILE,*)((W(I,J),I=1,IMAX),J=1,JMAX)
WRITE(IFILE,*)((T(I,J),I=1,IMAX),J=1,JMAX)
WRITE(IFILE,*)((Q(I,J),I=1,IMAX),J=1,JMAX)
WRITE(IFILE,*)((UW(I,J),I=1,IMAX),J=1,JMAX)
WRITE(IFILE,*)((VW(I,J),I=1,IMAX),J=1,JMAX)
WRITE(IFILE,*)((H(I,J),I=1,IMAX),J=1,JMAX)
WRITE(IFILE,*)((LH(I,J),I=1,IMAX),J=1,JMAX)

WRITE(IFILE,*)"5000M LEVEL"
```

CODE:

(1,JMAX) (IMAX,JMAX)

(1,1) (IMAX,1)

(b) Time series at each of 21 surface stations.

```
     WRITE(IFILE,*)"SURFACE VALUES"

 IT IS INDEX FOR TIME, AND N IS STATION INDEX
     WRITE(IFILE,*)((T(IT,N),IT=1,ITMAX),N=1,NMAX)
     WRITE(IFILE,*)((TD(IT,N),IT=1,ITMAX),N=1,NMAX)
     WRITE(IFILE,*)((RSU(IT,N),IT=1,ITMAX),N=1,NMAX)
     WRITE(IFILE,*)((RSD(IT,N),IT=1,ITMAX),N=1,NMAX)
     WRITE(IFILE,*)((RSU(IT,N),IT=1,ITMAX),N=1,NMAX)
     WRITE(IFILE,*)((RLD(IT,N),IT=1,ITMAX),N=1,NMAX)
     WRITE(IFILE,*)((SH(IT,N),IT=1,ITMAX),N=1,NMAX)
     WRITE(IFILE,*)((SLH(IT,N),IT=1,ITMAX),N=1,NMAX)
     WRITE(IFILE,*)((HG(IT,N),IT=1,ITMAX),N=1,NMAX)
     WRITE(IFILE,*)((RR(IT,N),IT=1,ITMAX),N=1,NMAX)

     WRITE(IFILE,*)"2 M LEVEL VALUES"
     WRITE(IFILE,*)((U(IT,N),IT=1,ITMAX),N=1,NMAX)
     WRITE(IFILE,*)((V(IT,N),IT=1,ITMAX),N=1,NMAX)
     WRITE(IFILE,*)((T(IT,N),IT=1,ITMAX),N=1,NMAX)
     WRITE(IFILE,*)((TD(IT,N),IT=1,ITMAX),N=1,NMAX)
     WRITE(IFILE,*)((UW(IT,N),IT=1,ITMAX),N=1,NMAX)
     WRITE(IFILE,*)((VW(IT,N),IT=1,ITMAX),N=1,NMAX)

     WRITE(IFILE,*)"10 M LEVEL VALUES"
******** USE THE SAME FORMATS AT 2M LEVEL
```

(c) Vertical profiles at each of 5 upper-air stations

```
 K IS THE INDEX FOR DIFFERENT LEVELS
 K=1, THROUGH 7 FOR 2,10,50,100,200,400, AND 800 M, RESPECTIVELY,
 K=8, THROUGH 11 FOR 850,700,500,AND 300 MB LEVEL, RESPECTIVELY
 IT IS THE INDEX FOR TIME
 N IS THE INDEX FOR STATION

     WRITE(IFILE,*)(((U(K,IT,N),K=1,KMAX),IT=1,ITMAX),N=1,NMAX)
     WRITE(IFILE,*)(((V(K,IT,N),K=1,KMAX),IT=1,ITMAX),N=1,NMAX)
     WRITE(IFILE,*)(((T(K,IT,N),K=1,KMAX),IT=1,ITMAX),N=1,NMAX)
     WRITE(IFILE,*)(((TD(K,IT,N),K=1,KMAX),IT=1,ITMAX),N=1,NMAX)
```

ANNEX 2.

MODEL OUTPUTS.

The following outputs are required on floppy disks (MS-DOS IBM format; either $5^1/4$in, 1.2m or 360K; or $3^1/2$in,1.44m) by 15 Jan 1992. These will be examined at ASL. A subset of the outputs, the same for each participant, will be selected for inclusion as horizontal fields and graphs in a pre-workshop volume.

The current state of mesoscale modelling technology can best be assessed through this project if all the data sets are produced and it is hoped that the majority of participants will succeed in achieving this. We recognise, however, that the amount of work involved is large and that some modellers may have difficulty in producing all the outputs on schedule due to time conflicts or interruptions. Therefore we recommend the priorities as indicated for completion of the data sets. Analysis of Phase 1 has priority over Phase 2; In each Phase data sets will be allocated the priorities I to III as indicated below, with I being the highest priority.

In the specifications below the symbols in brackets following the field descriptions are interpreted on the separate notation list.

Records for the two WIND phases should be submitted on separate disks.

(a) Horizontal fields.

Every 3 hr (09,12,15,...06,09) i.e. at nearest time step to hour:

(i) At the surface (Priority II):

On a 41X41 5km Universal Transverse Mercator (UTM) grid with SW corner reference at 39° 11′ 4.4″ N, 122° 59′ 57.9″ W:

- Sensible heat flux (SH)
- Latent heat flux (SLH)
- Horizontal momentum flux (SM)
- Pressure deviation from initial(09) value (P)
- Precipitation in past 3hr (R).

(ii) At 10m:

On the same grid as (i):

Primary variables (Priority I):

- Zonal wind component (U)
- Meridional wind component (V)
- Vertical motion (W) - average over past hour
- Temperature (T)
- Specific humidity (Q)

Subgrid turbulent fluxes (Priority II) of

- Zonal wind (UW)
- Meridional wind (VW)
- Sensible heat (H)
- Latent heat (LH)

Every 6 hr (09,15,21,03,09):

(iii) At 500m:

Primary variables (Priority I)
Turbulent fluxes (Priority II)

On a 21X21 10 km UTM grid with same SW corner reference as for 5 km grid:

Same fields as for (ii)

(iv) At 5000m:

Primary variables (Priority II)
Turbulent fluxes (Priority III)

Same fields as for (iii).

Notes.

1. The data should be recorded on disk as signed integers in the range -998 to +999 in ASCII format i.e. with each grid-point value occupying 4 bytes. e.g. (see notation list) a surface heat flux of 87.3 Wm^{-2} should appear as +087, a westerly zonal wind of 15.2 ms^{-1} as +152, a temperature of 13.7degC as +137, a specific humidity of 11.2 gm/kg as +112 and a sub-grid turbulent flux of zonal wind of 3.6 $\times 10^{-2}$ Pa downwards as -036. Numbers should not be separated by a space or any other character and the + and - are mandatory. The number -999 is reserved as a missing data indicator. Each complete record should consist of a header followed by an array of 41X41 (or 21X21) numbers obtained from 41 (or 21) scans from W to E across the grid starting with the southernmost row. The units indicated on the notation sheet have been suggested to provide the accuracy needed for the workshop proceedings. Should values using these units fall outside the above range they will need to be scaled and the adjusted scaling indicated in the header. The header format is presented in Annex 2A.

2. The data records should be ordered as follows:

09:Surface (SH,SLH,SM,P,R); 10m (U,V,W,T,UW,VW,H,LH);
500m (U,V,W,T,UW,VW,H,LH); 5000m (U,V,W,T,UW,VW,H,LH).
12:Surface (SH,SLH,SM,P,R); 10m (U,V,W,T,UW,VW,H,LH).
15:As 09.
18:As 12.
and so on to 09 of the next morning.

(b) Time series at each of 21 surface stations.

Hourly values i.e. values at the time step nearest each hour (09,10,...08,09) of

(i) At the surface (Priority I):

Temperature (T)
Dew point (TD)
Upward solar radiation (RSU)
Downward solar radiation (RSD)
Upward long-wave radiation (RLU)
Downward long-wave radiation (RLD)
Sensible heat flux (SH)
Latent heat flux (SLH)

Heat flux into ground (HG)
Precipitation rate during past hour (RR).

(ii) At 2m (Priority II):
Zonal wind component (U)
Meridional wind component (V)
Temperature (T)
Dew point (TD)
Sub-grid scale turbulent flux of zonal wind (UW)
Sub-grid scale flux of meridional wind (VW)

(iii) At 10m (Priority II):
As for 2m but excluding UW,VW.

Notes.

1. Values will need to be interpolated at each station from surrounding grid points. The procedure used is left to the discretion of individual participants; Please specify briefly in covering note accompanying disks.

2 Each record should consist of 25 hourly values, each in the ASCII format of a signed integer in the range -998 to +999., preceeded by a header. The header format is given in Annex 2A.

3. Complete sets of records must be provided for each station before proceeding to the next, stations being taken in the order S1,S2,...S14,BS2,C1, C7,BC3. For each station the data records should be ordered as follows:

Surface: T,TD,RSU,RSD,RLU,RLD,SH,SLH,HG,RR.
2m: U,V,T,TD,UW,VW.
10m: U,V,T,TD.

(c) **Vertical profiles at each of 5 upper air stations.**

Every 2 hours (09,11,13, 09)
at 2,10 50,100,200,400,800m above the ground and at standard reporting levels 850,700,500 and 300 hPa:
Zonal wind component (U)
Meridional wind component (V)
Temperature (T)
Dew point (TD)

Notes.

1. The method of interpolating the data to the stations and to the above heights above ground and pressure surfaces is left to the discretion of each participating group (to be briefly described in a covering letter accompanying the disks).

2. Each record should consist of a complete vertical set of 11 values starting at 2m in ASCII format of signed integers in the range -998 to +999 preceeded by a header. The header format is given in Annex 2A.

3. The complete set of records should be given for each station before proceeding to the next, stations being taken in the order 01,02,03,04,05. For each station the data records should be ordered as follows:

09hr: U,V,T,TD;
11hr: U,V,T,TD;
13hr: U,V,T,TD;
and so on.

ANNEX 3

3-DAY WORKSHOP ON TECHNOLOGY EXCHANGE IN MESOSCALE MODELLING

16-18
JUNE 1992

(Provisionally at El Paso Airport Hilton)

PROVISIONAL AGENDA

Tuesday 9 June	
Welcoming and Opening Remarks	Mr. Morris
Introduction to Workshop	Prof. Pearce
Project WIND Data Overview	Mr. Cionco
Session on Models and Model Results (each modeller allocated 30 mins plus 10 mins discussion to highlight his results and compare with WIND data)	Modellers
Wednesday 10 June	
Overview of Comparison Results	Mr. Meyers
Special Topics with invited speakers:	
Model Formulation/Numerics	Mr. Meyers
Initialisation and Boundary Layer	
Sub-gridscale Parameterisation	
Terrain and Surface Effects	
Thursday 11 June	
Continuation of Special Topics	
Moisture	
Radiation	
Model Evaluation Techniques	
Wrap-up Conclusions	Prof. Pearce
Close of Workshop	